whatever is visible. Therefore as the spectra of prominences and of storms may be stated to be the spectra of the hottest regions of the sun that we can get at in our inquiries. The lines in the solar spectrum affected neither in spots nor flames give us an approach to the cool spectrum we are in search of. We might expect if differences were observable that we should get something like this—

Lines special to prominences ... ... = hottest.
Lines special to spots ... ... = medium.
Lines affected neither in spots nor storms.. = coolest.

How have these views been tested. The first attempt made to get light out of this inquiry was one which simply dealt with a long catalogue of lines observed by Prof. Young in the memorable expedition of his to Mount Sherman, where, at the height of between 8000 and 9000 feet, with perfect weather and admirable instrumental appliances, about a month was employed in getting such a catalogue of lines as had never been got before. But it was found that, although the result of this inquiry was absolutely in harmony with these views, still after all one wanted more facts. Therefore we have endeavoured to get some of the facts here. And the way in which they have been collected is as follows:—During the last two years the spectra of 100 sun-spots have been observed in the observatory here—observed in a new fashion, and for a good reason I think. In this changeable climate it does not do to do as we began by doing—to attempt to observe all the lines acted upon in a solar spot. The excessive complication, and the intense variation of a spot-spectrum from the ordinary solar spectrum, cannot be better shown than by throwing on the screen the spectrum of one of the sun-spots lately observed at Greenwich.

The figure (Fig. 34) shows a limited part of the solar spectrum, and the lines thickened in the spot-spectrum. It will be seen therefore that to tabulate the existence and thickness and intensities of these lines over the whole of the solar spectrum would be a work which it would be difficult to accomplish in a single day, even if the day were absolutely fine. So that was given up in favour of a limited inquiry over a small part of the solar spectrum; limited further by this, that we only get the twelve lines most affected in each spot on each day. In this way we insure a considerable number of absolutely comparable observations, and we can more easily compare the spot results with those which had been obtained in the observation of the brightest lines in prominences, because when we begin to observe lines in the solar prominences one naturally begins by observing the brightest lines first. So that by observing the darkest lines first in the case of spots, one has a fairer comparison.

A diagram (Fig. 35) will show the result of our observations of 100 spots over a very limited part of the solar spectrum. We will begin by the individual observations. We have at the top the iron lines recorded among the Fraunhofer lines; below we have the iron lines recorded as iron lines by Ångström, who used an electric arc. Lower down we have the iron lines recorded by Thalèn, who used the electric spark. It will be seen that there is a very considerable difference in the spectrum of iron as viewed by means of the spark and by means of the arc, and that there is an equal difference between the spectrum of iron in the sun, that is to say, in the whole sun, determined by the Fraunhofer lines, and the spectrum of either the arc or the spark. It is also to be noted that the solar spectrum is more like the spectrum of the arc than the spectrum of the spark.

Since the relative intensities in all these cases are represented by the length of the lines, we have here an opportunity of observing and discussing the accuracy of Kirchhoff's statement that the iron lines in the sun correspond absolutely in intensity with the lines of iron seen in a light source here. It is necessary first of all to see which light source he fixes on, whether the arc or the spark. When this has been done it is found that the statement is really true with regard to neither.

That however is a digression; to proceed with the diagram, descending from this general spectrum of iron which we get by the absorption of the whole atmosphere of the sun independently of the hottest region and the coldest region—descending from the general to the particular—and taking that particular part of the solar atmosphere where the spots produce their phenomena, let us see what are the results in the case of the spots? We have in the vertical lines a record of the lines which are affected in each spot, and each of the spaces included between the horizontal lines represents a particular spot, the date being given on the right hand side; and these 100 lines which we have here represent the phenomena produced by 100 spots. The diagram is a small portion of the larger map. Now the wonderful thing that one is at once struck with is the absolute and complete irregularity of the whole result. There is no continuity among any of these lines. A careful inspection of the diagram shows us that, speaking in a general way, each of these lines is seen in one spot or another absolutely without the other. We have an *inversion* in the intensities of the lines when passing from spot to spot. Whenever we get a line intensified by Thalen, we miss it in the spots, and, as a rule, what happens is that the spectrum of the spot is not only simpler than the spectrum of the arc, but simpler than the spectrum of the spark.

Now the importance of these statements depends on other statements which we can bring to confront with them. The next diagram shows the observations of 100 prominences observed between the years 1872 and 1876. (The diagram was thrown on the screen.) Prominences exist in a region of the solar atmosphere not very far from that occupied by the spots, but we have already seen that whereas the spots are produced by a downrush of cool material, prominences are produced by an uprush of hot material. Let us see therefore if any change is produced in the phenomena; whether we shall have exactly the same lines from the flames, or the prominences, as we have from the spots; whether we shall get the same information or no.

Here are the facts with respect to Tacchini's observations:—We begin as before with the whole absorption of the sun, Ångström's map, and Thalèn's map. I think you will see a very considerable change; the iron lines (for we are only dealing with iron) most prominent in the prominences are vastly different from the iron lines most thickened in the spots. The difference is shown in the annexed diagram (Fig. 36), which represents those individual observations both of spots and flames treated in a certain way with reference to the discussion. I will at once explain to you what that certain way is. We have, as before, the three data to begin with, and we have treated the sun-spot observations so that the lengths of the lines will represent the number of times they have been seen in 100 sun-spots; the line at wave-length 4919·5, for instance, has been seen seventy-two times; *that* line, in fact, has been seen more than any other; the one at 5005·0 some forty times, and so on; very many lines having been seen less than ten times. In another part of the same diagram we have summarised the individual results obtained from Tacchini's observation of prominences in exactly the same way. The line 5017·5 was seen in 66 prominences out of 100. But why I am particularly anxious to show this diagram is this, that it brings out the perfectly natural fact—for it is the natural fact—that over this region of the spectrum, at all events, no iron lines affected in the spots are visible in the prominences. If we assume that the region occupied by prominences is hotter than the region occupied by spots, that higher region ought to do this work, and it ought to be a work of simplification. Therefore I say it is a perfectly natural result, and not one to be wondered at, that in the spectra of the flames there is no line coincident with any of the lines seen frequently widened in the spots.

Now we have these three solar spectra here which we can compare one with the other. First of all we have the iron spectrum of the sun taken as a whole. Then we have next the spectrum of spots, which we know to be hotter than the sun taken as a whole. Then we have the spectrum of flames, which we know to be hotter than the spots. It will be seen that the story, as it runs from the top of the diagram downwards, is a story of greater simplicity, as it ought to be, and it was explained in the diagram which I exhibited before I began to show these results of absolute hard facts. It will be seen that the simplicity brought about by the reduction of lines actually seen as to number, is accompanied by the appearance of new lines (produced by the transcendental temperatures) in these regions. This first discussion of a large number of spectra and of spots, as compared with storms, is, I submit, in absolute harmony with the view of the dissociation of the elementary bodies by the solar temperature suggested by Sir Benjamin Brodie in 1867, and therefore I may further add that to me, at all events, it is absolutely inexplicable on any other view.

J. NORMAN LOCKYER

(*To be continued.*)

INTERNATIONAL MEDICAL CONGRESS

THIS Congress, which opened by an informal reception at the College of Physicians on Tuesday, has so far been a real success. It has brought together something

like 2500 medical men, no less than 1000 being from abroad, and 500 from the provinces. Indeed, the attendance is more than double that of any previous Congress. Among the distinguished foreigners who attend the Congress are the following:—Dr. Fordyce Barker, New York; Dr. Billings, Washington; Dr. Bigelow, Boston; Professors Brown-Séquard, Paris; Chauveau, Lyons; Donders, Utrecht; Professors Holmgren, Upsala; His, Leipsic; Kölliker, Wurzburg; Klebs, Prague; Loven, Stockholm; Pasteur, Paris; Pflüger, Bonn; Panteleoni, Rome; Von Slawjansky, St. Petersburg; Stokvis, Amsterdam; Virchow, Berlin. A very large concourse of members thronged the rooms of the College on Tuesday, and crowded St. James's Hall yesterday morning, when Sir James Paget delivered the presidential address. The sectional meetings are being held in the rooms of the various scientific societies in the Burlington House region, and there are fifteen of them altogether. Prof. Virchow gave an address last night on "The Value of Pathological Experiments." To-day Prof. Maurice Raynaud gives a general address on "Scepticism in Medicine"; to-morrow Dr. Billings of Washington gives an address on "Our Medical Literature"; and to-morrow night the Lord Mayor and Corporation receive the members in the Guildhall at a *conversazione*. On Saturday there will be several excursions, and Sir Joseph Hooker will hold a reception at Kew in the afternoon. On Monday at a general meeting Prof. Volkmann of Halle will lecture on "Modern Surgery"; and on Tuesday Prof. Huxley will lecture on "The Connection of the Biological Sciences with Medicine." We this week give the opening address of Sir James Paget:—

As I look round this hall my admiration is moved not only by the number and total power of the minds which are here, but by their diversity, a diversity in which I believe they fairly represent the whole of those who are engaged in the cultivation of our science. For here are minds representing the distinctive characters of all the most gifted and most educated nations; characters still distinctly national, in spite of the constantly increasing intercourse of the nations. And from many of these nations we have both elder and younger men; thoughtful men and practical; men of fact and men of imagination; some confident, some sceptic; various, also, in education, in purpose and mode of study, in disposition, and in power. And scarcely less various are the places and all the circumstances in which those who are here have collected and have been using their knowledge. For I think that our calling is pre-eminent in its range of opportunities for scientific study. It is not only that the pure science of human life may match with the largest of the natural sciences in the complexity of its subject-matter; not only that the living human body is, in both its material and its indwelling forces, the most complex thing yet known, but that in our practical duties this most complex thing is presented to us in an almost infinite multiformity. For in practice we are occupied, not with a type and pattern of the human nature, but with all its varieties in all classes of men, of every age and every occupation, and all climates and all social states; we have to study men singly and in multitudes, in poverty and in wealth, in wise and unwise living, in health and all the varieties of disease; and we have to learn, or at least try to learn, the results of all these conditions of life while, in successive generations and in the mingling of families, they are heaped together, confused, and always changing. In every one of all these conditions man, in mind and body, must be studied by us; and every one of them offers some different problems for inquiry and solution. Wherever our duty or our scientific curiosity, or, in happy combination, both, may lead us, there are the materials and there the opportunities for separate original research.

Now, from these various opportunities of study, men are here in Congress. Surely, whatever a multitude and diversity of minds can in a few days do for the promotion of knowledge, may be done here.

But it is not proposed to leave the work of the Congress to what would seem like chances and disorder, good as the result might be; nor yet to the personal influences by which we may all be made fitter for work, though these may be very potent. In the stir and controversy of meetings such as we shall have, there cannot fail to be useful emulation; by the examples that will appear of success in research, many will be moved to more enthusiasm, many to more keen study of the truth; our range of work will be made wider, and we shall gain that greater interest in each other's views and that clearer apprehension of them which are always attained by personal acquaintance and by memories of association in pleasure as well as in work. But as it will not be left to chance, so neither will sentiment have to fulfil the chief duties of the Congress.

Following the good example of our predecessors, certain subjects have been selected which will be chiefly, though not exclusively, discussed, and the discussions are to be in the sections into which we shall soon divide.

Of these subjects it would not be for me to speak even if I were competent to do so; unless I may say that they are so numerous and complete that—together with the opening addresses of the Presidents of Sections—they leave me nothing but such generalities as may seem commonplace. They have been selected, after the custom of former meetings, from the most stirring and practical questions of the day; they are those which must occupy men's minds, and on which there is at this time most reason to expect progress, or even a just decision, from very wide discussion. They will be discussed by those most learned in them, and in many instances by those who have spent months or years in studying them, and who now offer their work for criticism and judgment.

I will only observe that the subjects selected in every section involve questions in the solution of which all the varieties of mind and knowledge of which I have spoken may find their use. For there are questions, not only on many subjects, but in all stages of progress towards settlement. In some the chief need seems to be the collection of facts well observed by many persons. I say by many, not only because many facts are wanted, but because in all difficult research it is well that each apparent fact should be observed by many; for things are not what they appear to each one mind. In that which each man believes that he observes, there is something of himself; and for certainty, even on matters of fact, we often need the agreement of many minds, that the personal element of each may be counteracted. And much more is this necessary in the consideration of the many questions which are to be decided by discussing the several values of admitted facts and of probabilities, and of the conclusions drawn from them. For, on questions such as these minds of all kinds may be well employed. Here there will be occasion even for those which are not unconditionally praiseworthy, such as those that habitually doubt, and those to whom the invention of arguments is more pleasing than the mere search for truth. Nay, we may be able to observe the utility even of error. We may not indeed wish for a prevalence of errors; they are not more desirable than are the crime and misery which evoke charity. And yet in a congress we may palliate them, for we may see how, as we may often read in history, errors, like doubts and contrary pleadings, serve to bring out the truth, to make it express itself in clearest terms and show its whole strength and value. Adversity is an excellent school for truth as well as for virtue.

But that which I would chiefly note, in relation to the great variety of minds which are here, is that it is characteristic of that mental pliancy and readiness for variation which is essential to all scientific progress, and which a great international congress may illustrate and promote. In all the subjects for discussion we look for the attainment of some novelty and change in knowledge or belief; and after every such change there must ensue a change in some of the conditions of thinking and of working. Now, for all these changes minds need to be pliant and quick to adjust themselves. For all progressive science there must be minds that are young whatever may be their age.

Just as the discovery of auscultation brought to us the necessity for a refined cultivation of the sense of hearing, which was before of only the same use in medicine as in the common business of life; or, as the employment of the numerical method in estimating the value of facts required that minds should be able to record and think in ways previously unused; or, as the acceptance of the doctrine of evolution has changed the course of thinking in whole departments of science: so is it, in less measure, in every less advance of knowledge. All such advances change the circumstances of the mental life, and minds that cannot or will not adjust themselves become less useful, or must at least modify their manner of utility. They may continue to

be the best defenders of what is true; they may strengthen and expand the truth, and may apply it in practice with all the advantages of experience; they may thus secure the possessions of science and use them well; but they will not increase them.

It is with minds as with living bodies. One of their chief powers is in their self-adjustment to the varying conditions in which they have to live. Generally those species are the strongest and most abiding that can thrive in the widest range of climate and of food. And of all the races of men they are the mightiest and most noble who are, or by self-adjustment can become, most fit for all the new conditions of existence in which by various changes they may be placed. These are they who prosper in great changes of their social state; who, in successive generations, grow stronger by the production of a population so various that some are fitted to each of all the conditions of material and mode of life which they can discover or invent. These are most prosperous in the highest civilisation; these whom nature adapts to the products of their own arts.

Or, among other groups, the mightiest are those who are strong alike on land and sea; who can explore and colonise, and in every climate can replenish the earth and subdue it; and this not by tenacity or mere robustness, but rather by pliancy and the production of varieties fit to abide and increase in all the various conditions of the world around.

Now it is by no distant analogy that we trace the likeness between these in their successful contests with the material conditions of life and those who are to succeed in the intellectual strife with the difficulties of science and of art. There must be minds which in variety may match with all the varieties of the subject-matters and minds which, at once or in swift succession, can be adjusted to all the increasing and changing modes of thought and work.

Such are the minds we need; or rather, such are the minds we have; and these in great meetings prove and augment their worth. Happily the natural increase in the variety of minds in all cultivated races is—whether as cause or as consequence—nearly proportionate to the increasing variety of knowledge. And it has become proverbial, and is nearly true in science and art, as it is in commerce and in national life, that, whatever work is to be done, men are found or soon produced who are exactly fit to do it.

But it need not be denied that, in the possession of this first and chiefest power for the increase of knowledge, there is a source of weakness. In works done by dissimilar and independent minds, dispersed in different fields of study, or only gathered into self-assorted groups, there is apt to be discord and great waste of power. There is therefore need that the workers should from time to time be brought to some consent and unity of purpose; that they should have opportunity for conference and mutual criticism, for mutual help and the tests of free discussion. This it is which, on the largest scale and most effectually, our Congress may achieve; not indeed by striving after a useless and happily impossible uniformity of mind or method, but by diminishing the lesser evil of waste and discord which is attached to the far greater good of diversity and independence. Now as in numbers and variety the Congress may represent the whole multitude of workers everywhere dispersed, so in its gathering and concord it may represent a common consent that, though we may be far apart and different, yet our work is and shall be essentially one; in all its parts mutually dependent, mutually helpful, in no part complete or self-sufficient. We may thus declare that as we who are many are met to be members of one body, so our work for science shall be one, though manifold; that as we, who are of many nations, will for a-time forget our nationalities and will even repress our patriotism, unless for the promotion of a friendly rivalry, so will we in our work, whether here and now or everywhere and always, have one end and one design—the promotion of the whole science and whole art of healing.

It may seem to be a denial of this declaration of unity that, after this general meeting, we shall separate into sections more numerous than in any former Congress. Let me speak of these sections to defend them; for some maintain that, even in such a division of studies as these may encourage, there is a mischievous dispersion of forces. The science of medicine, which used to be praised as one and indivisible, is broken-up, they say, among specialists, who work in conflict rather than in concert, and with mutual distrust more than mutual help.

But let it be observed that the sections which we have instituted are only some of those which are already recognised in many countries, in separate societies, each of which has its own place and rules of self-government and its own literature. And the division has taken place naturally in the course of events which could not be hindered. For the partial separation of medicine, first from the other natural sciences, and now into sections of its own, has been due to the increase of knowledge being far greater than the increase of individual mental power.

I do not doubt that the average mental power constantly increases in the successive generations of all well-trained peoples; but it does not increase so fast as knowledge does, and thus in every science, as well as in our own, a small portion of the whole sum of knowledge has become as much as even a large mind can hold and duly cultivate. Many of us must, for practical life, have a fair acquaintance with many parts of our science, but none can hold it all; and for complete knowledge, or for research, or for safely thinking-out beyond what is known, no one can hope for success unless by limiting himself within the few divisions of the science for which, by nature or by education, he is best fitted. Thus, our division into sections is only an instance of that division of labour which, in every prosperous nation, we see in every field of active life and which is always justified by more work better done.

Moreover, it cannot be said that in any of our sections there is not enough for a full strong mind to do. If any one will doubt this let him try his own strength in the discussions of several of them.

In truth, the fault of specialism is not in narrowness, but in the shallowness and the belief in self-sufficiency with which it is apt to be associated. If the field of any specialty in science be narrow, it can be dug deeply. In science, as in mining, a very narrow shaft, if only it be carried deep enough, may reach the richest stores of wealth and find use for all the appliances of scientific art. Not in medicine alone, but in every department of knowledge, some of the grandest results of research and of learning, broad and deep, are to be found in monographs on subjects that, to the common mind, seemed small and trivial.

And study in a Congress such as this may be a useful remedy for self-sufficiency. Here every group may find a rare occasion, not only for an opportune assertion of the supreme excellence of its own range and mode of study, but for the observation of the work of every other. Each section may show that its own facts must be deemed sure, and that by them every suggestion from without must be tested; but each may learn to doubt every inference of its own which is not consistent with the facts or reasonable beliefs of others; each may observe how much there is in the knowledge of others which should be mingled with its own; and the sum of all may be the wholesome conviction of all, that we cannot justly estimate the value of a doctrine in one part of our science till it has been tried in many or in all.

We were taught this in our schools; and many of us have taught that all the parts of medical science are necessary to the education of the complete practitioner. In the independence of later life some of us seem too ready to believe that the parts we severally choose may be self-sufficient, and that what others are learning cannot much concern us. A fair study of the whole work of the Congress may convince us of the fallacy of this belief. We may see that the test of truth in every part must be in the patient and impartial trial of its adjustment with what is true in every other. All perfect organisations bear this test; all parts of the whole body of scientific truth should be tried by it.

Moreover, I would not, from a scientific point of view, admit any estimate of the comparative importance of the several divisions of our science, however widely they may differ in their present utilities. And this I would think right, not only because my office as president binds me to a strict impartiality and to the claim of freedom of research for all, but because we are very imperfect judges of the whole value of any knowledge, or even of single facts. For every fact in science, wherever gathered, has not only a present value, which we may be able to estimate, but a living and germinal power of which none can guess the issue.

It would be difficult to think of anything that seemed less likely to acquire practical utility than those researches of the few naturalists who, from Leeuwenhoeck to Ehrenberg, studied the most minute of living things, the Vibrionidæ. Men boasting themselves as practical might ask, "What good can come of it?" Time and scientific industry have answered, "This good: those researches have given a more true form to one of the most important practical doctrines of organic chemistry; they have introduced a great beneficial change in the most practical part of

surgery; they are leading to one as great in the practice of medicine; they concern the highest interests of agriculture, and their power is not yet exhausted.

And as practical men were, in this instance, incompetent judges of the value of scientific facts, so were men of science at fault when they missed the discovery of anæsthetics. Year after year the influences of laughing-gas and of ether were shown: the one fell to the level of the wonders displayed by itinerant lecturers, students made fun with the other; they were the merest practical men, men looking for nothing but what might be straightway useful, who made the great discovery which has borne fruit not only in the mitigation of suffering, but in a wide range of physiological science.

The history of science has many similar facts, and they may teach that any man will be both wise and dutiful if he will patiently and thoughtfully do the best he can in the field of work in which, whether by choice or chance, his lot is cast. There let him, at least, search for truth, reflect on it, and record it accurately; let him imitate that accuracy and completeness of which I think we may boast that we have, in the descriptions of the human body, the highest instance yet attained in any branch of knowledge. Truth so recorded cannot remain barren.

In thus speaking of the value of careful observation and records of facts, I seem to be in agreement with the officers of all the sections; for, without any intended consent, they have all proposed such subjects for discussion as can be decided only by well-directed facts and fair direct inductions from them. There are no questions on theories or mere doctrines. This, I am sure, may be ascribed, not to any disregard of the value of good reasoning or of reasonable hypotheses, but partly to the just belief that such things are ill-suited for discussion in large meetings, and partly to the fact that we have no great opponent schools, no great parties named after leaders or leading doctrines about which we are in the habit of disputing. In every section the di cussions are to be on definite questions, which, even if they be associated with theory or general doctrines, may yet be soon brought to the test of fact; there is to be no use of doctrinal touchstones.

I am speaking of no science but our own. I do not doubt that in others there is advantage in dogma, or in the guidance of a central organising power, or in divisions and conflicting parties. But in the medical sciences I believe that the existence of parties founded on dominant theories has always been injurious; a sign of satisfaction with plausible errors, or with knowledge which was even for the time imperfect. Such parties used to exist, and the personal histories of their leaders are some of the most attractive parts of the history of medicine: but, although in some instances an enthusiasm for the master-mind may have stirred a few men to unusual industry, yet very soon the disciples seem to have been fascinated by the distinctive doctrine, content to bear its name, and to cease from active scientific work. The dominance of doctrine has promoted the habit of inference, and repressed that of careful observation and induction. It has encouraged that fallacy to which we are all too prone, that we have at length reached an elevated sure position on which we may rest, and only think and guide. In this way specialism in doctrine or in method of study has hindered the progress of science more than the specialism which has attached itself to the study of one organ or of one method of practice. This kind of specialism may enslave inferior minds: the specialism of doctrine can enchant into mere dreaming those that should be strong and alert in the work of free research.

I speak the more earnestly of this because it may be said, if our Congress be representative, as it surely is, may we not legislate? May we not declare some general doctrines which may be used as tests and as guides for future study? We had better not.

The best work of our International Congress is in the clearing and strengthening of the knowledge of realities; in bringing, year after year, all its force of numbers and varieties of minds to press forward the demonstration and diffusion of truth as nearly to completion as may from year to year be possible. Thus, chiefly, our Congress may maintain and invigorate the life of our science. And the progress of science must be as that of life. It sounds well to speak of the temple of science, and of building and crowning the edifice. But the body of science is not as any dead thing of human work, however beautiful; it is as something living, capable of development and a better growth in every part. For, as in all life the attainment of the highest condition is only possible through the timely passing-by of the less good, that it may be replaced by the better, so is it in science. As time passes, that which seemed true and was very good becomes relatively imperfect truth, and the truth more nearly perfect takes its place.

We may read the history of the progress of truth in science as a paleontology. Many things which, as we look far back, appear, like errors, monstrous and uncouth creatures, were, in their time, good and useful, as good as possible. They were the lower and less perfect forms of truth which, amid the floods and stifling atmospheres of error, still survived; and just as each successive condition of the organic world was necessary to the evolution of the next following higher state, so from these were slowly evolved the better forms of truth which we now hold.

This thought of the likeness between the progress of scientific truth and the history of organic life may give us all the better courage in a work which we cannot hope to complete, and in which we see continual, and sometimes disheartening, change. It is, at least, full of comfort to those of us who are growing old. We that can read in memory the history of half a century might look back with shame and deep regret at the imperfections of our early knowledge if we might not be sure that we held, and sometimes helped onward, the best things that were, in their time, possible, and that they were necessary steps to the better present, even as the present is to the still better future. Yes—to the far better future; for there is no course of nature more certain than is the upward progress of science. We may seem to move in circles, but they are the circles of a constantly ascending spiral; we may seem to sway from side to side, but it is only as on a steep ascent which must be climbed in zig-zag.

What may be the knowledge of the future none can guess. If we could conceive a limit to the total sum of mental power which will be possessed by future multitudes of well-instructed men, yet could we not conceive a limit to the discovery of the properties of materials which they will bend to their service. We may find the limit of the power of our unaided limbs and senses; but we cannot guess at a limit to the means by which they may be assisted, or to the invention of instruments which will become only a little more separate from our mental selves than are the outer sense-organs with which we are constructed.

In the certainty of this progress the great question for us is what shall we contribute to it? It will not be easy to match the recent past. The advance of medical knowledge within one's memory is amazing, whether reckoned in the wonders of the science not yet applied, or in practical results in the general lengthening of life, or, which is still better, in the prevention and decrease of pain and misery, and in the increase of working power. I cannot count or recount all that in this time has been done; and I suppose there are very few, if any, who can justly tell whether the progress of medicine has been equal to that of any other great branch of knowledge during the same time. I believe it has been; I know that the same rate of progress cannot be maintained without the constant and wise work of thousands of good intellects; and the mere maintenance of the same rate is not enough, for the rate of the progress of science should constantly increase. That in the last fifty years was at least twice as great as that in the previous fifty. What will it be in the next, or, for a more useful question, what shall we contribute to it?

I have no right to prescribe for more than this week. In this let us do heartily the proper work of the Congress, teaching, learning, discussing, looking for new lines for research, planning for mutual help, forming new friendships. It will be hard work if we will do it well; but we have not met for mere amusement or for recreation, though for that I hope you will find fair provision, and enjoy it the better for the work preceding it.

And when we part let us bear away with us, not only much more knowledge than we came with, but some of the lessons for our conduct in the future which we may learn in reflecting the work of our Congress.

In the number and intensity of the questions brought before us, we may see something of our responsibility. If we could gather into thought the amounts of misery or happiness, of helplessness or of power for work, which may depend on the answers to all the questions that will come before us, this might be a measure of our responsibility. But we cannot count it; let us imagine it; we cannot even in imagination exaggerate it. Let us bear it always in our mind, and remind ourselves that our responsibility will constantly increase. For, as men become in the best sense better educated, and the influence of scientific knowledge on their moral and social state

increases, so among all sciences there is none of which the influence, and therefore the responsibility, will increase more than ours, because none more intimately concerns man's happiness and working power.

But, more clearly in the recollections of the Congress, we may be reminded that in our science there may be, or, rather, there really is, a complete community of interest among men of all nations. On all the questions before us we can differ, discuss, dispute, and stand in earnest rivalry; but all consistently with friendship, all with readiness to wait patiently till more knowledge shall decide which is in the right. Let us resolutely hold to this when we are apart: let our internationality be a clear abiding sentiment, to be, as now, declared and celebrated at appointed times, but never to be forgotten; we may, perhaps, help to gain a new honour for science, if we thus suggest that in many more things, if they were as deeply and dispassionately studied, there might be found the same complete identity of international interests as in ours.

And then, let us always remind ourselves of the nobility of our calling. I dare to claim for it, that among all the sciences, ours, in the pursuit and use of truth, offers the most complete and constant union of those three qualities which have the greatest charm for pure and active minds—novelty, utility, and charity. These three, which are sometimes in so lamentable disunion, as in the attractions of novelty without either utility or charity, are in our researches so combined that, unless by force or wilful wrong, they hardly can be put asunder. And each of them is admirable in its kind. For in every search for truth we can not only exercise curiosity, and have the delight—the really elemental happiness—of watching the unveiling of a mystery, but, on the way to truth, if we look well round us, we shall see that we are passing wonders more than the eye or mind can fully apprehend. And as one of the perfections of nature is that in all her works wonder is harmonised with utility, so is it with our science. In every truth attained there is utility either at hand or among the certainties of the future. And this utility is not selfish: it is not in any degree correlative with money-making; it may generally be estimated in the welfare of others better than in our own. Some of us may indeed make money and grow rich; but many of those that minister even to the follies and vices of mankind can make much more money than we. In all things costly and vainglorious they would far surpass us if we would compete with them. We had better not compete where wealth is the highest evidence of success; we can compete with the world in the nobler ambition of being counted among the learned and the good who strive to make the future better and happier than the past. And to this we shall attain if we will remind ourselves that, as in every pursuit of knowledge there is the charm of novelty, and in every attainment of truth utility, so in every use of it there may be charity. I do not mean only the charity which is in hospitals or in the service of the poor, great as is the privilege of our calling in that we may be its chief ministers; but that wider charity which is practised in a constant sympathy and gentleness, in patience and self-devotion. And it is surely fair to hold that, as in every search for knowledge we may strengthen our intellectual power, so in every practical employment of it we may, if we will, improve our moral nature; we may obey the whole law of Christian love, we may illustrate the highest induction of scientific philanthropy.

Let us, then, resolve to devote ourselves to the promotion of the whole science, art, and charity of medicine. Let this resolve be to us as a vow of brotherhood; and may God held us in our work.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, July 25.—M. Wurtz in the chair.—The following papers were read:—On the comet *b* of 1881, by M. Mouchez. The result of M. Oudemans' search among the Dutch Colonial Archives in South Africa is that the comet of 1881 is probably not that of 1807, but seen now for the first time.—Determination of the horizontal and lateral flexure and the flexure of the instrumental axis of the meridian circle of Bischoffsheim, by means of new apparatus, by MM. Lœwy and Perigaud.—On the equivalence of quadratic forms, by M. Jordan.—On chlorhydric ether of glycol, by M. Berthelot.—Anthracic vaccination; *résumé* of experiments made at Lambert, near Chartres, to test the method of M. Pasteur, by M. Bouley. The essence of the test consisted in inoculating vaccinated sheep with natural virus (anthracic blood from a sheep which died of the disease) instead of that prepared by processes of culture. The efficacy of the vaccination was fully demonstrated.—On the irreducible covariants of the binary quantic of the eighth order, by Prof. Sylvester.—Parabolic elements of the comet *b* 1881, by M. Bigourdan.—Observations of Schæberle's comet (*c* 1881) at Paris Observatory, by M. Bigourdan; also by MM. Henry.—Considerations on the forces of nature; inadmissibility of the hypothesis proposed by M. Faye to explain the tails of comets, by M. Picard. Whatever the nature of the repulsive force it can only be proportional to masses, not to surfaces, for *ideal* pressure on surfaces only arises from *effective* action on masses. No interposed matter can weaken or arrest its action, for the etherised medium penetrates all bodies. The action is propagated, not successively but instantaneously, being due not to an undulatory motion, but to shocks of etherised atoms and ponderable molecules, like gravitation; hence on a point in motion it is exerted in the same direction as the attraction exercised by the ponderable mass of the sun.—Remarks on the calculation of relative perturbations, according to M. Gyldén's method, by M. Callandreau.—Hemihedral crystals with inclined faces as constant sources of electricity, by MM. Jacques and Pierre Curie. A plate suitably cut in such a crystal and placed between two sheets of tin forms a condenser which becomes charged when it is compressed. The authors give an absolute measure of the quantities of electricity liberated by tourmaline and quartz for a determinate pressure. It is shown how the instrument may serve in comparison of charges and capacities.—Determination of the angular distance of colours, by M. Rosenstiehl. He shows that three colours previously referred to, viz. orange, the third yellow green, and the third blue, have the characters of a triad (that is, mixed in equal intensity, they produce the sensation of white). All the colours which occupy the angles of an inscribed equilateral triangle have the same properties.—Electric stopcock; transformation, transport, and use of energy, by M. Cabanellas.—On the heat of formation of explosives, by MM. Sarrau and Vieille. When an explosive is decomposed the heat liberated is equal (according to thermodynamics) to the excess of the heat of formation of the products over the heat of formation of the explosive. Hence, knowing, in a given case, the heat liberated by decomposition, and the composition of the products of the reaction, the heat of formation may be arrived at. The authors have applied the method to the principal explosives, and will shortly give the results.—Industry of magnesia (continued), by M. Schlœsing. He treats sewage matter with phosphate of magnesia, obtaining the phosphoric acid from natural phosphates of lime, and the magnesia from sea-water or water of salt marshes (it is precipitated by slaked lime). He produces a sort of vermicelli of lime, which gives a porous magnesia, on which the acid liquid acts easily.—On some reactions of morphine and its congeners, by M. Grimaux.—On a new process of vaccination of chicken cholera, by M. Toussaint. He inoculated fowls with blood of rabbits which had died of septicemia (or with matter cultivated from it), and the effects were those of an attenuated virus, which made the fowls refractory to cholera.—On a volcanic breccia capable of being utilised as an agricultural manure, by M. Carnot. The rock (from l'Herault) contains notable amounts of iron, lime, potash, and phosphoric acid.—Boric acid; its existence in salt lakes of the modern period, and in natural saline waters (second note), by M. Dieulafait.—On the extraordinary temperature of July, 1881, by M. Renou. It rose to 38°·4 on the 19th at the Park Observatory, a degree never experienced in Algiers, the Antilles, and Cayenne.

CONTENTS